MPA MaterialsMatter

July 2008

INSIDE

Dipen Sinha receives Distinguished Patent Award

Dipen Sinha (MPA-11) received the Distinguished Patent Award for his invention, "Noninvasive Characterization of a Flowing Multiphase Fluid Using Ultrasonic Interferometry," at Los Alamos National Laboratory's 2007 Technology Transfer Awards reception. The reception took place in May at Fuller Lodge. Sinha's invention is an apparatus and method that uses ultrasound to non-invasively monitor the flow rate and/or the composition of a flowing fluid. It has been licensed to Safety Scan and Chevron.

Sinha's invention has been licensed to Safety Scan and Chevron.

The Technology Transfer Awards recognize employees whose technologies have received patents during the past year, employees who have received royalty income from patented and copyrighted work, and employees who have demonstrated an exemplary effort to participate in all facets of technology transfer. The awards recognize Laboratory innovators and include recognitions for Distinguished Patent, Copyright, and License Awards, along with the Programmatic, and Regional Impact awards.

Dipen Sinha (MPA-11) received a Distinguished Patent Award for his invention, "Noninvasive Characterization of a Flowing Multiphase Fluid Using Ultrasonic Interferometry," from PADSTE Deputy Director Ducan McBranch at the Los Alamos National Laboratory 2007 Technology Transfer Awards reception.

Technology Transfer Division, which coordinates Laboratory technology transfer efforts, hosted the reception along with Laboratory Counsel. The Intellectual Property Office co-sponsored the event. Manuel Gonzalez, Chevron's manager for the Advanced Energy Solutions Alliance with Los Alamos, delivered the keynote address. Deputy Principal Associate Director for Science, Technology and EngineeringDuncan McBranch presented the awards. A total of 92 Laboratory inventors were recognized for the 46 U.S. patents issued.

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From Alex's Desk

MPA: Materials, materials, materials... and materials

In my June note from the desk, I described the MPA Division's work on strategic planning. I find the planning to be of paramount importance to the future of our Division and I see good progress so far. We are not done yet, and will take longer. I'm okay with that and I also see the final product to be a "living" document. Los Alamos National Laboratory is also starting to have a global look at strategic directions. The Laboratory approach relates to "Building the Future of Los Alamos as the Premier National Security Science Laboratory."

Connected to that ADEPS is working on a strategic plan focusing on materials for the future. Three areas will be addressed: predictive performance, extreme environments, and emergent phenomena led by MST Division Leader Paul Follansbee, MST-8 Group Leader Anna Zurek, and myself. I recognize how broad "emergent phenomena" is and I have the full intent of addressing topics from hard to soft matter, experimental tools, and also how to achieve a continuum from fundamental understanding of materials to its applications. This will be a challenging task and I'll need help. I have started working with a group of technical leaders Laboratory-wide and our goal is to address: (1) science grand challenges, (2) facility requirements, (3) the basic to applied continuum, and as a result, a high-level business plan.

I have to mention, however, I do understand and recognize there is some degree of skepticism on what are we trying to accomplish; from my prospective we have accomplished a lot since we started to focus on materials research in the Institution.

A couple of examples I would like to mention relate to our recent success on materials-related LDRD-DR awards and as an Institution, plans for MaRIE as the Institution signature facility. Bottom line, even with our limited investments in "free energy," having a business plan in place where science goals, staffing plans, and facility needs are well articulated will be beneficial now and the future.

Recent events

On July 8, Los Alamos hosted a group of researchers and managers from SK Energy Co., Ltd. , Seoul, South Korea. Visitors included Dr. DongHyong Sheen, head, vice president; Dr. InHo Cho, vice president; Mr. ChanHo Moon, senior manager (team leader); Dr. BoyoungIn Lee, senior scientist; and Mr. JongHyun Kim, manager, all from the SK Energy Co., Ltd. The Institutional host for the visit was Duncan McBranch, PADSTE. SK Energy is the leading energy company in South Korea with a very diverse research and development program. During the one-day visit MPA-MC Group Leader Kevin Ott gave a talk on catalysis and hydrogen storage; MPA-MC's Mark McCleskey presented approaches to materials for energy applications, and I gave an overview related to energy materials technology at Los Alamos.

On July 18, Assistant Secretary Alexander Karsner of DOE - Energy Efficiency and Renewable Energy visited Los Alamos. MPA was well represented in two poster sessions: Rod Borup and Piotr Zelenay (MPA-11) described fuel cell durability, Mark McCleskey (MPA-MC) solid state lighting, Fernando Garzon (MPA-11) sensors, and Albert Migliori (MPA-NHMFL) energy storage.

MPA-MC researchers (Brian Scott and Mark McClesky), in collaboration with Elizabeth Hong-Geller, Anu Chaudhary (B-7), and S. Gnanakaran (T-10) have their recent work featured in Chemical Communications (Feature article, Chem. Commun. 2837–2847 (2008)), and highlighted in the Royal Chemical Society publication Chemical Biology.

The team investigated the bioinorganic chemistry and associated immunology of chronic beryllium disease (CBD). I was amazed to learn that during the year 2000 alone, the United States used around 390 tons of beryllium, from computer products to dental prosthetics; so it of great importance to understand and eventually find a cure for CBD. The work focuses on speciation, inhalation and dissolution, and immunology.

Electronic structure of superconductivity refined

Neil Harrison and Charles Mielke (MPA-NHMFL), along with an international team of physicists (including Cambridge University and University of British Columbia), propose a new model that expands on a little understood aspect of the electronic structure in high-temperature superconductors. Their research represents a step toward figuring out the mechanics of superconductivity, and revolutionizing energy efficiency in, for example, mass transportation, electricity transmission, and power storage.

Since the discovery of ceramic materials containing copper oxide that can conduct electricity with no resistance at relatively high temperatures—at least above the temperature of liquid nitrogen (approximately -320°F)—it has been thought that changes in the behavior of a single carrier type were governing this unusual property. Now, their team has put forth the idea that two types of carriers may be involved.

Experiments made last year revealed the existence of electron carriers. These are, atomically speaking, very light and thinly spread, so they wouldn't be likely to have a great effect on the behavior of a compound throughout the relevant temperature range. But a second type of carrier, called holes, which are heavier and more numerous, might better help explain the origin of superconductivity. Their team reports its findings in the July 10 edition of Nature in a letter titled, "A multi-component Fermi surface in the vortex state of an underdoped high-Tc superconductor."

Small-scale laser experiment achieves sufficient x-ray flux for ion temperature diagnostic

Roger Shurter, Martin Taccetti (P-24) and Peter Goodwin (MPA-CINT) developed a small-scale laser experiment that achieved sufficient x-ray flux for their ion temperature diagnostic using the recently upgraded short-pulse laser system located at TA-35 B86. They obtained ~4.5 times more x-ray flux on film than previously possible by using 4.5X more laser energy. As this was done at 40% less than the full beam energy available for this diagnostic, they feel confident in achieving the 5X x-ray flux identified in last year's milestone review as required for achieving sufficient signal at the desired resolution.

Crab pulsars and MPA: yes we do that too

The discovery of pulsars resulted in a Nobel prize in astronomy. In the past 40 years since its discovery, however, there has been no convincing theory to explain the emission spectra of pulsars. John Singleton (MPA-NHMFL), Marion Perez (ISR-1) and collaborators from the United Kingdom reported the first observation in their article published in the Monthly Notices of the Royal Astronomical Society. Using essentially only two adjustable parameters, they are able to predict the emission of the Crab pulsar over 16 orders of magnitude of frequency and fine detail of the GHz spectrum of the Crab. Both are in exceptionally good agreement with observations

Congratulations go to Jim Werner, Guillaume Lessard, Nathan Wells, and Peter Goodwin (all MPA-CINT) on the 3D Tracking Microscope project (one of the two Los Alamos projects) selected to receive the prestigious R&D Magazine R&D 100 Award. They have developed the only confocal microscope capable of following the motion of nanometer-sized objects, such as quantum dots, organic fluorophores, single green fluorescent proteins, as they move through three-dimensional space at rates faster than many intracellular transport processes. The awards, which will be presented October 16 in Chicago, recognize the top 100 industrial innovations worldwide in 2008.

Elizabeth Hong-Geller, Anu Chaudhary, Brian Scott, T. Mark McCleskey, and S. Gnanakaran

Congratulations also go to MPA's LANL 2008 Postdoctoral Distinguished Performance Awards:

Ki-Yong Kim (MPA-CINT) was recognized for his achievements in the development of ultrafast terahertz (THz) radiation as a single-shot diagnostic to study electronic transport properties of materials, warm dense plasmas, dynamic strain and shocks, and for characterization of short pulse electron bunches generated from intense laser-based electron accelerators.

Pinaki Sengupta (T-11 and MPA-NHMFL) has made several important contributions to quantum magnetism theory including explaining the origin of a novel sequence of magnetization plateaus in the Shastry-Sutherland magnetic insulator SrCu2 (BO3)2, previously measured by Suchitra Sebastian (Cambridge) and Neil Harrison (MPA-NHMFL).

Marken is new MPA-STC Center Leader

Ken Marken

Please join me in congratulating Ken Marken as the selected STC Center Leader. Ken earned his BS in physics from William and Mary and his PhD in materials science from the University of Wisconsin-Madison. He studied processing-microstructure-property correlations in Nb3Sn filamentary composites for his dissertation work and has remained involved in superconductor research and development for more than 25 years. He spent five years at Battelle-Columbus working on low temperature superconductors, high temperature superconductors, and magnetic materials, including some of the first work in the U.S. on the problem of grain connectivity in YBCO ceramic superconductors. In his 15 years at Oxford Instruments he led the effort to develop and commercialize Nb3Sn composites that enabled the world's 900 MHz nuclear magnetic resonance spectroscopy magnet and he was directly responsible for development of BiSCCO-2212 conductors that enabled the world's first 25 tesla superconducting magnet insert. Ken has 15 years of line management experience in a superconductor research and development group and more than 20 years experience in project management for superconductor development.

New MPA members – MPA-11: the fuel cell and sensors programs are growing

Paul Mombourquette, formerly MST-7, recently joined MPA-11 as a research technologist 1, where he will be developing electronics packages in support of acoustic research with Dipen Sinha and his team.

Paul started work at Los Alamos in 1985 at the electronics prototype shop and transferred to the Ion Beam Materials Laboratory two years later to build the safety interlock system for the 2 Mev accelerator for Joe Tesmer. In 1989 he became a laboratory employee working in the powder metallurgy section of MST-6, designing and implementing process controls. In May 2000 Paul took a job with a nanopropulsion company in Irvine, California where he developed the data acquisition and control of hybrid rocket motors burning nanoparticle-size aluminum powder. Paul returned to Los Alamos in 2003, working in MST-7 on electrical controls and serving as the group electrical safety officer. In 2005, Paul completed his homebuilt Sonerai aircraft and successfully test-flew it at Moriarty.

Recent postdoctoral researcher to TSM conversions: Christina M. Johnston and Jacob S. Spendelow

Christina completed her PhD studies in chemistry at the University of Illinois at Urbana-Champaign in 2005. During this time, she held a National Science Foundation (NSF) graduate fellowship. Her dissertation work focused on characterizing single crystal platinum and gold surfaces modified with ruthenium and/or osmium deposits, and understanding methanol and carbon monoxide electrooxidation on these catalytic surfaces. She was awarded a Director's Postdoctoral Fellowship appointment at Los Alamos in 2005, and was converted to a technical staff member in March. Her current interests include alternative support materials for platinum catalysts in proton exchange membrane fuel cells (PEFCs), and understanding the impact of electrode composition and structure on cathode performance in PEFCs.

Jacob received his PhD in chemical engineering from the University of Illinois at Urbana-Champaign in 2006, where he was funded by a NSF graduate research fellowship. He joined MPA-11 in August 2006 as a Director's Postdoctoral Fellow. His research interests include development and characterization of novel electrocatalytic materials for low temperature fuel cells, and water management in operating polymer electrolyte membrane fuel cells.

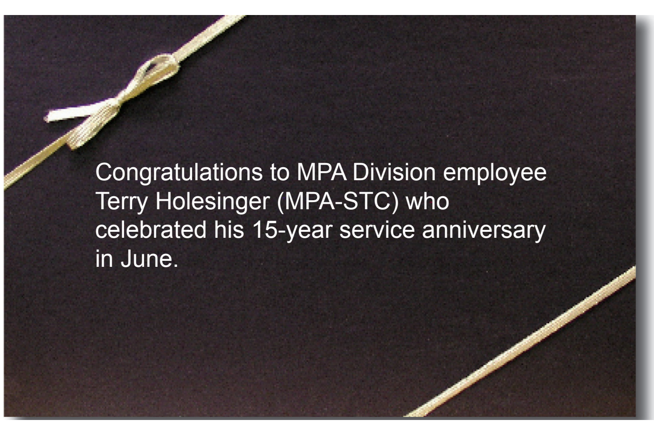
And last but certainly not least...

Please keep engaging with MPA's WSST team members. Any team member would be happy discussing and working with you on any safety issues.

MPA- WSST team members include Chris Sheehan (chair), MPA-STC; Carmen Espinoza, MPA-10; Roger Lujan, MPA-11; Clay Macomber, MPA-MC; Chuck Mielke, MPA-NHMFL; Darrell Roybal, MPA-NHMFL, and Darrick Williams, MPA-CINT. For more information about MPA-WSST, please visit int.lanl.gov/orgs/mpa/mpa_wsst/index.shtml.

- Alex Lacerda, Interim MPA Division Leader

Celebrating service



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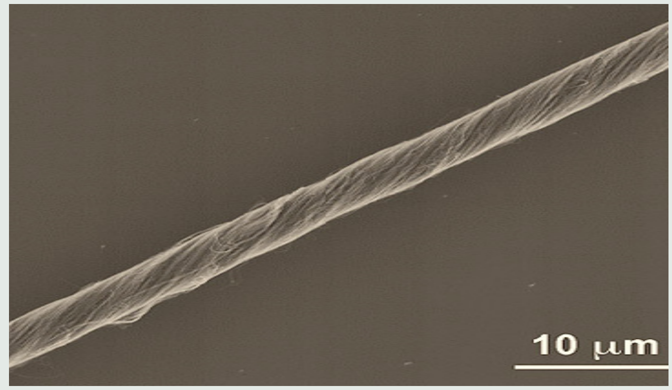
Carbon nanotube array paper named "fast-breaking paper" by ScienceWatch.com

A paper describing growth of ultralong carbon nanotube arrays for fiber spinning by made the April list of Thomson Scientific, ScienceWatch.com's "Fast Breaking Papers." The paper, "Sustained Growth of Ultralong Carbon Nanotube Arrays for Fiber Spinning", published in *Advanced Materials* has co-authors X. F. Zhang, R. F. DePaula, L. S. Zhen, Y. H. Zhao, L. Stan, T. G. Holesinger, P. N. Arendt, and D. E. Peterson (all in MPA- STC); and former MPA-STC members Yuntian Zhu and Qingwen Li.



Carbon nanotube fiber (yarn) spun from 1 mm array.

The researchers used ion beam assisted deposition to deposit the buffer layer and catalyst film and a low hydrogen concentration to make the process safer, cheaper, and conducive to large-scale production. The nanotube fibers spun from the long arrays have a much higher specific strength and much better conductivity than those spun from shorter arrays by other researchers. These fibers have potential for advanced applications, such as ultrahigh strength fibers for aerospace structure and supercapacitors for energy storage.

The principal authors, Zhu and Li, were interviewed about the significance of this work by ScienceWatch.com: sciencewatch.com/dr/fbp/2008/08aprfbp/08aprfbpZhu_Li/

Essential Science Indicators from Thomson Scientific lists highly cited papers in 22 broad scientific fields. These papers are the top 1% of papers in each field each year. The lists are updated with current citation counts and include new papers that enter the top percentile.

ScienceWatch.com identifies a subset of these papers having the largest percentage increase in citations in their respective fields from one bimonthly update to the next. These "fast breaking papers" represent recent scientific contributions that are just beginning to attract the attention of the scientific community.

MPA well represented at the Materials Research Society spring meeting

MPA researchers gave five invited presentations at the Materials Research Society's spring meeting.

Andrew Dattelbaum (MPA-CINT)--presenting for Basil Swanson (C-DO)-- gave a paper titled, "Signal Transduction Using Nanobio Materials: Application to Biological Sensing." Their coauthors were **Jennifer Martinez** (MPA-CINT), Aaron Anderson (C-CPS), Andrew Beveridge (B-9), Karen Grace (ISR-4), Wynn Grace (C- CPS), Harshini Mukundan (C-CPS), and Jurgen Schmidt (B-9).

Jackie Kiplinger (MPA-10) gave a paper titled, "Magnetic and Electronic Communication in Multimetallic f-Element Complexes." Her coauthors were **Christopher R. Graves, Eric J. Schelter, Joe Thompson,** and **Anthony E. Vaughn** (all of MPA-10), **Brian L. Scott** (MPA-MC), and **David E. Morris** (MPA-CINT).

Boris Maiorov (MPA-STC) gave a paper titled, "General Trends for Manipulating Pinning Landscape in $YBa_2Cu_3O_7$ Films." His coauthors were **Honghui Zhou, Scott A. Baily, Ozan Ugurlu, John A. Kennison, Paul C. Dowden, Terry G. Holesinger, Steve R. Foltyn**, and **Leonardo Civale** (all from MPA-STC).

Albert Migliori (MPA-NHMFL) gave a his paper titled, "Plutonium Elastic Moduli, Electron Localization, and Temperature."

Amit Misra (MPA-CINT) gave his paper titled, "Limits of Strength and Ductility of Nanolayered Metallic Composites."

MSCookies & Tea's new coordinators eager for your ideas

Veronica Livescu (MST-8) and Boris Maiorov (MPA-STC) are MSCookies & Tea's new coordinators, replac¬ing MPA-MC's Rico Del Sesto and MPA-CINT's Amit Misra.

Both are eager to hear your ideas on future topics for the Tuesday afternoon informal seminar series designed to give researchers an opportunity to discuss a wide variety of scientific and non-technical topics.

With two master's degrees, in aerospace engineering and mechanical engineering, Livescu joined Los Alamos in 2002. Originally from Romania, she is a member of MST-8's Dynamic Materials Team, where her work concentrates on advanced quantitative characterization of microstructural damage in materials subjected to dynamic loading conditions and supports the development of predictive damage models. She can be reached at vlivescu@lanl.gov.

Maiorov, who holds a PhD in physics from the Instituto Balseiro, Bariloche, Argentina, joined Los Alamos in 2003 as a postdoctoral researcher in MPA-STC. The technical staff member works in understanding vortex pinning properties of superconductors as well as techniques to increase the critical current in these materials. His research is focused on superconductivity and vortex physics, as models to study strongly interacting systems and as a tool for improving the pinning properties of high temperature superconductors. He can be reached at maiorov@lanl.gov.

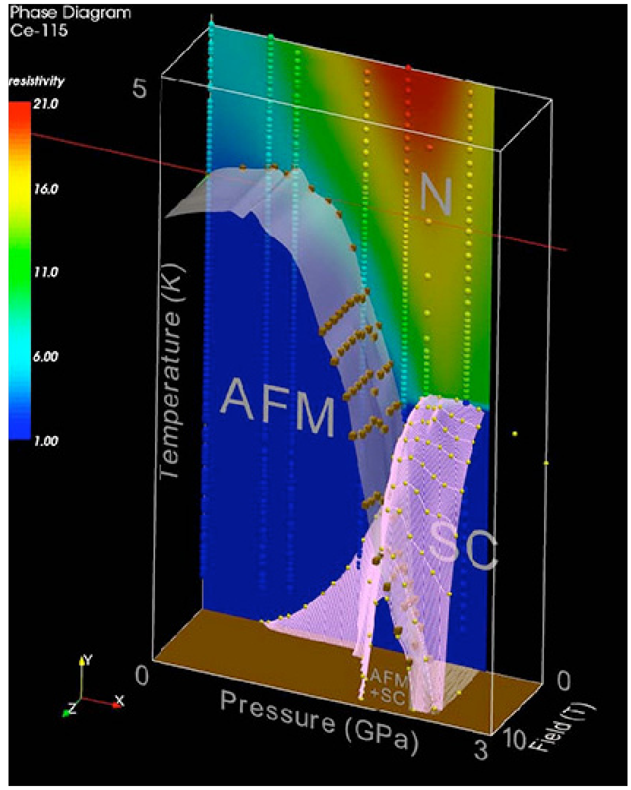
MST Cookies & Tea is held on Tuesdays at 4 p.m. in the MSL Meeting Place (TA-3, Bldg. 1698, A104). Social gatherings alternate with informal speakers, who range from students sharing their results to upper management discussing their outlook on the Laboratory's future. The gatherings are an excellent opportunity to meet with other researchers to discuss data, network, and eat tasty cookies and drink tea.

Veronica Livescu (above) of MST-8's Dynamic Materials Team and Boris Maiorov (right) of MPA-STC are the new MSCookies & Tea coordinators.

For more information, see int.lanl.gov/orgs/mpa/MS_Cookies.shtml.

Electronic duality revealed in strongly correlated matter: findings reported in *Proceedings of National Academy of Sciences*

The discovery of electronic duality in a compound made of cerium-rhodium-indium provides a new conceptual framework that emerges in strongly correlated matter. In the early 1900s, scientists were baffled by experiments that showed that electrons acted like waves in one type of measurement and like hard spheres in other measurements. The advent of a quantum mechanics revolutionized science by proving that electrons act as both waves and particles. A century later, scientists now face a similar puzzle: the localization versus itinerancy of an electron in strongly correlated matter.



A century later, scientists now face a similar puzzle: the localization versus itinerancy of an electron in strongly correlated matter.

When the prototypical antiferromagnet $CeRhIn_5$ is squeezed by applying pressure, hybridization between the localized 4f electron of cerium and ligand electrons increases. Bulk unconventional superconductivity arises from pressure-enhanced itinerancy of 4f electrons, which simultaneously coexists with large-moment antiferromagnetic order among localized 4f electrons.

Electronic duality, where the single 4f electron of cerium plays simultaneous roles of being localized and magnetic, as well as being itinerant and superconducting, is distinctly different from conventional models that attribute coexisting spin-density wave magnetism and superconductivity to a Fermi-surface instability, posing fundamental theoretical challenge to capture the low-energy physics of duality from first-principle calculations.

The work, "Electronic duality in strongly correlated matter," by Tuson Park and Joe D. Thompson (MPA-10), Matthias J. Graf and Lev Boulaevskii (T-11), along with John L. Sarrao (SPO-SC), appears in the 2008 *Proceedings of the National Academy of Sciences* **105**(19):6825-6828.

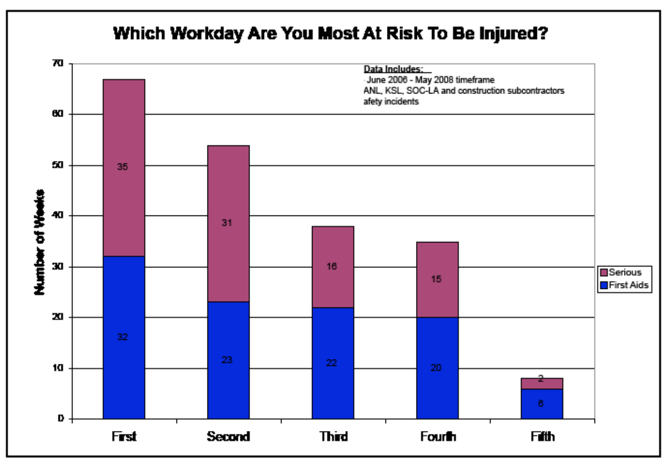
Work at Los Alamos National Laboratory was performed under the auspices of the US Department of Energy, Office of Science, and supported by the Los Alamos Laboratory Directed Research and Development program.

Research appears in *Nature Nanotechnology*
Crossing a bridge into the unknown

▲ *The Tacoma Narrows Bridge, which underwent a severe mechanical deformation and then collapsed owing to gale-force winds, is a good example of a driven harmonic oscillator. The nanomechanical resonator studied by Beil et al. is much smaller — 1.2 µm long, 300 nm wide and 200 nm deep — and can be used to study extreme events such as shock waves in the nanoworld.*

The March *Nature Nanotechnology* features a review by Charles (Chuck) Mielke (MPA-NHMFL) and Alexander Balatsky (T-11) titled, “Crossing a Bridge into the Unknown.” In their review, the authors report on the importance of research done by Florian Beil (Ludwigs-Maximilians-Universität in Munich) and co-workers in Germany and the U.S. Beil et al. demonstrate the ability to excite extreme states of motion, such as shock waves, in nanomechanical resonators. Their nanomechanical resonator is a bridge made by suspending a beam of gallium arsenide between two acoustic transducers. The researchers introduce a two-dimensional electron gas into the beam, which allows them to study interactions between the electrons and vibrations of the crystal lattice.

Mielke and Balatsky point out that the innovative aspect of the system is that it is possible to drive it to extremes, including shock velocities and conditions, in a controllable fashion. This ability will provide new insights into the interactions between electrons and phonons—a quantum of sound or vibratory elastic energy, the analogue of a hoton of electromagnetic energy. These interactions play a central role in superconductivity, spindensity waves, and many other phenomena in condensed-matter physics. These interactions are also becoming a topic of increasing interest in nanoscience. Mielke and Balatsky write that this kind of research “could scarcely have been imagined a few years ago. Nanomechanical devices will no doubt continue to push further into the quantum world, teaching us more about the interactions between electrons and phonons, and acting as a bridge into the unknown.”



Which workday are you most at risk to be injured?

Bethany Rich (Voluntary Protection Program Lead) complied injury data over the last two years to look for trends. One of the interesting findings is shown in the chart above. The chart shows that over the past two years, both first aid and serious (recordable) injuries occur more often on our first day back to work after a weekend. Remember that the first day back may not be a Monday if there is a holiday or snow day (thus, the label of First, Second, Third, etc. vs. Mon, Tues, Wed, etc.). There were 35 weeks in which the first day back had the most injuries for those weeks. The fifth day’s low injuries are largely due to the 9/80 schedule (fewer workers) and holidays reducing workweek length. What does this all mean to you? We suggest taking an extra bit of time on the first day back to review equipment configuration and how safely you are working.

Contact us at mpawsst@lanl.gov with any safety, security and environmental issues.